

# EFT Validity and Truncation Overview

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## DM: EFT validity procedure, intro

- EFTs useful for mono- $X$  searches due to minimal model dependence
- Past validity constraints shown to be insufficient by many papers
  - Even if EFT limits are usually conservative, the resulting constraints are not robust and may lead to non-perturbative couplings
- Consider the more realistic requirement:  $Q_{\text{tr}} \ll M_{\text{med}}$ 
  - Cannot quantify *much less than*, use minimal constraint:  $Q_{\text{tr}} < M_{\text{med}}$
- Particularly important for comparing to direct detection experiments
  - Very different energy scales:  $\mathcal{O}(\text{TeV})$  vs  $\mathcal{O}(\text{keV})$

## Recovering $M_{\text{med}}$ as a function of $M_*$

- EFT has integrated out  $M_{\text{med}}$ , but it can be retrieved as a function of  $M_*$  and couplings (and occasionally other factors)
  - Must assume a UV completion and involves unknown coupling values
- Simple mediator completion (D5 as in [ATLAS 14 TeV monojet PUB](#))

$$\sigma(pp \rightarrow \chi\chi + \text{jet}) \propto \frac{g_q^2 g_\chi^2}{(Q_{\text{tr}}^2 - M_{\text{med}}^2)^2 + \Gamma_{\text{med}}^2 M_{\text{med}}^2}$$
$$\xrightarrow{M_{\text{med}} \gg Q_{\text{tr}}, \Gamma_{\text{med}}} \frac{g_q^2 g_\chi^2}{M_{\text{med}}^4} \xrightarrow{\text{EFT}} \frac{1}{M_*^4} \therefore \boxed{M_{\text{med}} = \sqrt{g_q g_\chi} M_*}$$

- Other such completions are possible following more assumptions
  - D1, D9, C1 in [ATLAS HF+DM](#)
  - D5, D8, D9 in [ATLAS mono-photon](#)
  - More to follow
- Scanning over coupling parameter space provides idea of dependence
  - Typical theory assumption of *natural scale*: all couplings are 1
  - *Best case* for colliders: couplings at the perturbative limit, usually  $4\pi$

# Validity and truncation

- Can study the fraction of valid events  $R_{M_{\text{med}}}^{\text{tot}}$  as a function of coupling
- Use  $R_{M_{\text{med}}}^{\text{tot}}$  to rescale the nominal EFT limits,  $M_*^{\text{exp}}$ 
  - $M_*^{\text{valid}} = [R_{M_{\text{med}}}^{\text{tot}}]^{1/[2(d-4)]} M_*^{\text{exp}}$  (see [arxiv:1402.1275](https://arxiv.org/abs/1402.1275))
  - Note:  $d = 6$  for D5,D9,C1,C5 and  $d = 7$  for D1,D11
- ATLAS 14 TeV monojet (left) and mono-photon (right) examples:

